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ABSTRACT

A divergent thinking (DT) test format, scored for flexible and original thinking, is presented. The DT test format, designed to assess teacher competencies and estimate the transfer of competencies to new situations, was administered to graduate students enrolled in a testing course. The DT format allowed students to list phrases and sentence fragments; this procedure highlighted the purpose of the test, namely, to elicit flexible and original thinking. Fifty-six students, most of whom were certified teachers, were asked to use divergent thinking on a quiz. The purposes of the quiz were to: (1) instruct students in the art of testing through idea production; (2) measure students' subject matter achievement; and (3) approximate transfer of learning. Students were asked to: (1) list as many ideas as possible about the interpretation of a test they had administered; and (2) list five criteria for selecting the most important factors in the interpretation of test scores. The socring of this DT test is illustrated. Students who scored well drew on their recent experiences in test construction, scoring, and preparing report cards; recalled idea from instruction; and created new ideas during the quiz. The review of items listed by the students indicated that the DT test format measured course objectives as well as would conventional tests. Sample test responses are provided. (SLD)

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MEASUREMENT OF ACHIEVEMENT AND TRANSFER THROUGH DIVERGENT THINKING

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ABSTRACT

This article shows how divergent production can be used to measure levels of thinking not observed through conventional tests. The format requires that students list ideas about a given topic as a measure of achievement. Examples of lists written by elementary school and college students demonstrate performance. These lists are accompanied by examples of the scoring system used to show the variance in accomplishment.

TRANSFER OF LEARNING

As change continues to accelerate, it is almost certain that students will use most of what they learned in ways that differ from their school experiences. To adapt most of their knowledge and skills to environments that demand more information and new ways to use it, teachers and students need to think divergently. That is, they should be able to produce many ideas related to given topics, to produce ideas in different categories, to produce ideas original to themselves, and to elaborate on what they know.

The purpose of this article is to present a divergent-thinking (DT) test format, scored for flexible and original thinking, that is used (a) to assess teacher competencies and (b) to estimate the transfer of competencies to new situations. It is assumed that learning and testing through DT during training will increase the creative thinking that teachers must do on the job. The goal is to enable teachers to use and transform what they know in order to respond to the needs of today's students and to create the education of the future.

Consider first that transfer occurs through the kinds of thinking that

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students do (Tobias, 1982), and that divergent thinkers invent ways to use what they know and create what they do not know. It is flexible thinking, in particular, that induces students to generalize the effects of learning (Brown & Campione, 1981), and makes the mediators of transfer more effective. Recognized mediators include (a) the production of ideas in trials and other problem solving processes (Singer, 1978); (b) explanations that students assign to subject matter components (Mayer & Greeno, 1972); (c) the ways that students organize information in long-term memory (Egan & Greeno, 1973); and (d) planning, monitoring, and shifting categories (Sternberg, 1981a).

DIVERGENT THINKING AND LOCUS OF CONTROL

Transfer will be understood better when learning becomes a self-generating process (Wittrock, 1977). As individuals regard themselves as autonomous generators of knowledge, even reluctant learners move away from impulsive response and inefficient planning (Feuerstein, 1980).

With control of their thinking, students prolong exploration and increase evaluation. This leads to the generation of subject matter concepts and the creation of original solutions to problems that require imaginative leaps (Dirkes, 1978). According to Guilford (1967), learning is problem solving, and the ability to think independently is an important prerequisite for it.

Problem solving is impeded, however, by many faster learners who impose high-certainty requirements for responding (Postman, 1969). Their preference for low-error rates on familiar tasks curtails ideation. Since they consider multiple ideas to be errors, they limit experimentation and self-adjustment in career situations and in academic subject matter. Use of divergent thinking and transformation helps teachers avoid such rigidity.

TESTING THROUGH DIVERGENT THINKING

A variety of evaluative methods are gaining recognition in the social sciences (Nevo, 1983). This move offers an opportunity to evaluate long-range uses for learning with new test formats. Since the ways in which academic performance is measured tell students something about how they should learn, the testing process in itself should include elements of significant learning and of creative transfer of learning.

Beginning the search for measures of transfer, Sternberg (1981b) suggests that nonentrenched or novel measures of problem solving abilities characterize intelligence better than stereotyped question formats. Problem solving and social competence in a context are basic to intelligence (Sternberg, 1984). "Nonentrenched" tasks require conceptualization that involves strategy planning and execution. Such questions differ from the "entrenched" situations found on current achievement tests and other measures of teacher competencies.

Although tests scored for flexible and original ideas have been used to measure characteristics of creative thinking (Tor ce, 1976) and correlations between these characteristics and achievement (Feldhusen, Balhke & Treffinger, 1969), they have not been used for direct measurement of competencies and their transfer. Scoring flexibility and originality, however, would reinforce the kind of thinking that transfer requires and reward it in the university classroom.

The test described below includes a DT format that allows students to list phrases and sentence fragments, as long as they write enough to express ideas adequately. Students are not bound, therefore, to the rules of sentence structure and paragraph development demanded by essays. The message to them is that the purpose of the test is to solicit flexible and original thinking, and that their ideas are important.

VALIDITY AND RELIABILITY

Some preliminary observations point out ways in which test validity and reliability are maintained through a DT test format. Since divergent production prolongs attention to a situation, it stimulates latent ideas and combinations of previous responses. Teachers, acting in the role of students, produce ideas original to themselves as well as basic subject matter concepts. It is assumed that they are even more likely to implement ideas that they produce themselves than those that they memorized in a narrower question-answer format. This introduces usable (true) content to the test and, therefore, contributes to test validity.

The content unique to individuals is not the same for every teacher. Since it reflects the varied ways in which teachers will use what they learn, however, it reflects the purpose for the test. Measurement of transfer, therefore, alters the definition of content validity to include variable content.

In one sense, high fluency scorers add to the length of the test, thereby increasing its reliability. On conventional tests students who do not know that their thinking has been "verified" by a textbook author often withhold what they know, saying, "I didn't think it was right." In a career situation, they probably would use uncertain information or produce new ideas.

Since errors are not scored, the DT format encourages independent thinking and use of maximum time allotments for tests. This also prompts additional ideas and stimulates the production of ideas appropriate for unique teaching situations.

The extended thinking time used by fluent thinkers resembles career situations in which a first response is often improved during a sustained or subsequent experience. In the way that longer planning time correlates with

higher intelligence test scores (Sternberg, 1981b), deliberate fluency and flexibility prompts a higher quality of ideas (Parnes & Meadow, 1959).

Some thinkers have learned to alternate flexible thinking wi.. logic and sequential processing well enough to answer the "trick" questions that require intuition or insight on achievement and intelligence tests. One reason why the discrimination index is usually high for these questions is that few students have cultivated the DT abilities that insight requires. This raises questions about the advantage that divergent thinkers have. If all students had training in this kind of thinking, as they do on convergent thinking, their scores would be more reliable.

Because DT develops trust in self-productivity, it is an effective antidote for anxiety (Meeker, 1981; Dirkes, 1983). When students learn to rely on themselves, they have an alternative to the attitude expressed in "Either I know it or I don't."

An example illustrates how tests of divergent thinking can measure performance that convergent tests misrepresent. Asked to cut ten rectangles in half, children in grade four drew vertical, horizontal, and diagonal line segments in the first four rectangles "correctly." In the remaining rectangles, some children illustrated two nonequivalent regions (Figure 1). The division of one rectangle, therefore, would fail to measure an understanding of what it means to illustrate half of a region.

Figure 1: "Halves" of Rectangles

Out of the classroom, each new transfer situation becomes another test of achievement through creative thinking. Creative potential is independent of age and creative thinking may be tied more to personality than to intellectual

ability (Davis & Rimm, 1982). Characteristics include: (a) perseverance, the willingness to think, (b) confidence, trust in one's own productivity, and (c) willingness to risk. Each of these characteristics contribute to achievement on life tasks as well as those on classroom tests.

PERFORMANCE IN A DIVERGENT THINKING FORMAT

In a graduate course on testing in the classroom, 56 students in two class sections were introduced to the characteristics of divergent thinking and given enough experience with fluency, flexibility, and originality so that they would know what this criteria demanded. Toward the end of the course, they were asked to use divergent thinking on a quiz. The purpose of the quiz was three-fold: (a) to instruct students in the art of testing through idea production, (b) to measure their subject matter achievement, and (c) to approximate transfer of learning.

Most of the students were certified teachers. Their teaching levels and years of experience are indicated in Table 1.

TEACHING EXPERIENCE

	Location		Years Teaching			
	Rural	City	0	1-4	5-9	10+
ELEMENTARY SCHOOL	11	9		11	9	
MIDDLE SCHOOL	5	4		6	2	1
SECONDARY SCHOOL	9	10		10	8	1
COLLEGE		3		3		
NOT TEACHING			5			

Table 1: Schools and Experience of Teachers

THE TEST INSTRUMENT

Part I (12 minutes)

You checked a test that you administered at the end of January. The test will be included in the semester report card grade. List as many ideas as you can about the interpretation of the test scores.

Part II (3 minutes)

List five criteria for selecting the most important factors in the interpretation of the test scores.

SCORING

Fluency Score: the number of responses Range: 3 - 38 Median: 22

Responses were not counted if they repeated a concept in different words or if they were totally unrelated to "test interpretation," the given topic.

Points: 25-39 responses, 4 points, 18 students
20-24 responses, 3 points, 13 students
15-19 responses, 2 points, 16 students
1-14 responses, 1 point, 9 students

Flexibility Score: the number of categories Range: 2-9 Median: 6

The following category numbers were marked on student papers. In some cases, the flexibility score was raised by new responses in Part II. Note that the first six categories listed here pertain to test reliability and the next three to validity.

1. Physical conditions: room, student, time for test administration
2. Student attitude: anxiety, previous upsetting conditions at home or school, cheating, disinterest
3. Influences on performance: culture, reading ability, self-expression in essay questions, speed-power
4. Length of the test
5. Instruction and ability that differed from that received by the total class: previous year, attendance, intelligence

6. Teacher factors other than instruction: scoring consistency, clarity of test questions, choice of format for questions, item analysis

7. Subject matter: agreement between test and course objectives, methods used during instruction, thinking levels, mastery, criterion referenced test

8. Performance of the total class: central tendency, variability

9. Performance effects: concurrent and past performance of the student, effect on what to teach next

Originality Score: one point for responses given by fewer than four students

Total score: 15 Maximum fluency: 4 points
Maximum flexibility: 9 points
Maximum originality: 2 points

EXAMPLES OF TEST RESPONSES

Category numbers are placed after entries. "X" indicates that the item was not counted in the fluency score due to its repetition of a previous response. "O" indicates originality.

STUDENT A Test Interpretation Quiz

Scores: Fluency 4 (28 responses)
Flexibility 9
Originality 2 Total 15

Part I:

1. How did the entire class do 8
2. Was the test too easy? 5
3. Was the test too hard? x
4. Did I test for knowledge?
5. Did I test for higher levels of thinking?
6. Did all students finish? 4
7. Did I test over all concepts taught?
8. Does it reflect student's understanding of subject? 7
9. How did particular students compare to others in class?
10. Should scores influence the report card grade?
11. How far from the mean did particular students score?
12. time of day test was taken 1
13. student ability for test taking
14. question clarity 6
15. room conditions
16. difficulty level of questions x
17. student preparation time
18. type of test questions
19. teacher time spent on test preparation
20. confusing questions
21. objective questions
22. Was class well prepared for test?

23. subjective questions x
24. when test was graded
25. teacher's state of mind when grading x
26. time permitted for test (not enough)
27. test construction
28. Compare results to past years' performance. 9
29. reading level 3
30. questions confusing x
31. well constructed questions
32. Did cheating take place? 2
33. Did the test measure student's knowledge of the topic? x
34. Is there a better method for evaluating certain topics? 0
35. Any other alternative to grading?

Part II.

1. The things that help me to evaluate a student's performance more accurately
2. The things that tell me if the test really measured or evaluated a students' understanding of the material
3. The things that will help me do a better job in constructing future tests
4. The things that help show me what I need to do to help students learn

STUDENT B Test Interpretation Quiz

Scores: Fluency 1 (6)
Flexibility 5
Originality 0 Total 6

Part I:

1. The score on the test should be a percentage of the grade depending on the total number of grades for the grading period.

2. If this is the lowest grade of the grading period for the student, it may be an alternative to eliminate this grade in calculating the percentage for the report card. 9

3. The scores of the class will influence the average and all other statistics which will be given. 8

Part II:

1. student ability - Perhaps a "low" score is the best that student can do. 5
2. previous instruction - How effective have I been? 7
3. attitude of the student - motivation 2

DISCUSSION

Divergent-thinking tests can be administered to pairs of students in different rooms to develop team work and idea stimulation. Both partners write

responses which usually are not identical. The arrangement adds new interest to test-taking and encourages team collaboration in career situations.

Another option is to have students mark their own fluency scores and to name categories of responses. Point assignments and time allotments are adjusted according to the discretion of instructors. Incubation can be increased by announcing the general topic for divergence prior to the test date.

Listing multiple responses in a brief time period, teachers in the graduate course described above who scored well on the quiz (a) tapped their recent school experiences with test construction, scoring, and report cards; (b) recalled ideas from course instruction; and (c) created new ideas during the quiz. Since they responded from a broad stimulus and in their own language, it is assumed that they function as teachers in schools in the ways that they reported on the quiz. With more experience on divergent-thinking tests, students would evaluate better what they do in school and the uniqueness of their test responses would increase.

In the evaluation of subject matter achievement, it was clear that all students did not think of listing some of the primary outcomes of the course. It is assumed that they probably do not transfer this knowledge to school classrooms. Consideration of this data can be a sobering experience for instructors who might conclude that they are more comfortable without the new data that DT tests offer. Yet review of the items listed by students convinces most educators that course objectives have been measured at least as well as conventional tests measure them, and that capable students add original objectives.

Topics suggested by this study that require much more investigation are (a) the extent that divergent production scores measure achievement, (b)

knowledge of high-level performance in real-world tasks (Sternberg, 1981c), and (c) the effects of testing through divergent production on what teachers do to improve instruction. This research could influence educational priorities and lead to new test formats for the measurement of outcomes that are not assessed by conventional instruments.

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